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PARSONS ENGINEERING SCIENCE, INC.

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June 16, 1997

Major Ed Marchand
AFCEE/ERT
3207 North Road, Bldg. 532
Brooks AFB, Texas 78235-5363

Subject: Extended Bioventing Testing Results at Site FSA-1 (Former Tank Nos. 19 and 20), Air Force Plant 4, Texas (Contract No. F41624-92-8036, Order 17)

Dear Major Marchand:

Parsons Engineering Science, Inc. (Parsons ES) is pleased to submit the results of the extended bioventing testing at Site FSA-1 at Air Force Plant 4 (AFP4), located in Fort Worth, Texas. Soil gas samples were collected, and *in situ* respiration testing was performed by Parsons ES from 7 through 10 April 1997 to assess the extent of remediation completed during approximately 1 year of full-scale air injection bioventing. The purpose of this letter is to summarize site and bioventing activities to date, present the results of the most recent respiration testing and soil gas sampling, and make recommendations based on site data. The as-built bioventing system and sampling/respiration testing locations are illustrated on Figure 1. Table 1 (attached) summarizes soil analytical results and compares detected concentrations to the Texas Natural Resource Conservation Commission (TNRCC) soil screening criteria. The attached Tables 2 and 3 provide results of initial and 1-year soil gas sampling and respiration testing, respectively.

SITE/PROJECT HISTORY

Fuel Saturation Area No. 1 (FSA-1) is located south and east of Facilities Building 14 (Figure 1, attached). Reported contamination of soil and groundwater included fuels and solvents that had leaked from two 12,000-gallon-capacity underground storage tanks (USTs) and an underground JP-4 distribution pipe during the mid-1970s to the early 1980s (Rust, 1995). The JP-4 distribution piping was abandoned in 1988. The two former USTs (Tanks 19 and 20), which were located south of Building 14, were removed prior to December 22, 1988. These USTs had contained 2-butanone (Tank 19) and xylene (Tank 20). Although the United States Environmental Protection Agency (USEPA)-approved Record of Decision (ROD) (July 1996) recommended no further action for Site FSA-1, voluntary long-term groundwater monitoring is currently being performed by the Air Force.

The AFP4 baseline risk assessment (BRA) indicated that there was no unacceptable risk to human health or the environment from soil or groundwater contamination at

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FSA-1 (Rust, 1995). Nonetheless, voluntary remedial actions have been conducted by the Air Force to reduce the time required for long-term groundwater monitoring. These voluntary actions included free-product recovery, groundwater extraction and treatment, performance of a bioventing pilot test, and installation of full-scale bioventing system in the FSA-1 source area. The free-product recovery and groundwater extraction and treatment systems installed at FSA-1 are currently inactive.

The bioventing pilot test was performed at FSA-1 by Engineering Science, Inc. (ES) (now known as Parsons ES) from March 1993 through May 1994 as part of the Air Force Center for Environmental Excellence (AFCEE) Bioventing Pilot Test Initiative (Contract No. F33615-90-D-4014, Order 14). The installed pilot-scale bioventing system consisted of one vent well (VW), three vapor monitoring points (MPs), and a blower unit. During system installation, respiration and air permeability testing and soil and soil gas sampling also were performed. A detailed description of bioventing system design and initial site activities is provided in the Interim Pilot Test Results report prepared by ES (1993) for this site. The pilot test project included 1 year of system operation followed by soil gas sampling and respiration testing.

Soil and soil gas data collected at the completion of the 1-year pilot test indicated significant contaminant removal in the pilot test area, with almost complete removal of benzene, toluene, ethylbenzene, and xylenes (BTEX). Soil BTEX concentrations were reduced from an average of 44 milligrams per kilogram (mg/kg) to nondetectable levels. Soil total recoverable petroleum hydrocarbon (TRPH) results were inconclusive, with some increases and some decreases measured after 1 year of system operation. Soil gas concentrations of total BTEX were reduced from an average of 41 parts per million, volume (ppmv) to 1.2 ppmv across the site, and total volatile hydrocarbons (TVH) were reduced from an average of 25,000 ppmv to 290 ppmv. Complete results from the 1-year pilot test are presented in the 1-year bioventing test report memorandum (AFCEE, 1995).

Based on the success of the pilot test for cost-effective remediation of the hydrocarbon-contaminated soils at this site, FSA-1 was added to the AFCEE Extended Bioventing Program (Contract No. F41624-92-D-8036, Order 17). Under the extended program contract, funding was allocated for installation of a full-scale system (Option 4), an additional year of system operation and testing (Option 1), and for a confirmatory soil sampling event (Option 2) if results of the additional year of testing demonstrate that concentrations of BTEX have been remediated to levels where source area soils no longer pose a threat to groundwater quality.

The selected location for the full-scale bioventing system was near the south end of Building 14 in the vicinity of the two former USTs (Tanks 19 and 20), which were the primary sources of contamination. This location, which is south of the bioventing pilot test area, was selected to remediate the most highly contaminated soils identified at the site. The full-scale system was installed by Parsons ES in March 1996, and consists of three air injection VWs, three MPs, a blower system, and the associated controls and piping. This system was designed to deliver oxygen throughout the area of the most

highly contaminated unsaturated soils. During the full-scale system installation, respiration testing and soil and soil gas sampling were performed (Parsons ES, 1996a and 1996b). Full-scale system operation began on 12 March 1996 and continued until 10 March 1997.

Additional soil gas sampling and *in situ* respiration testing were performed from 7 through 10 April 1997 following 1 year of full-scale system operation. The system was shut down 28 days prior to testing to allow soils and soil gas to come to equilibrium and to allow comparison of 1-year and initial conditions. The blower system was restarted following testing to continue bioventing treatment of site soils. Results of the 1-year soil gas sampling and respiration testing are presented in Tables 2 and 3.

SITE SOIL DATA AND STATE OF TEXAS CRITERIA

Because the BRA concluded that there is no unacceptable risk to human health or the environment from soil or groundwater contamination at FSA-1, and the USEPA-approved ROD recommended no further action, there are no cleanup levels for soil and groundwater contamination for this site. However, for comparison purposes, results from the March 1996 soil sampling event presented in this section are compared to the generic TNRCC screening level of 100 mg/kg for total petroleum hydrocarbons (TPH) and the action levels of 0.5, 100, 70, and 560 mg/kg for benzene, toluene, ethylbenzene, and xylenes, respectively (TNRCC, 1996).

Soil sampling has not been performed at Site FSA-1 since installation of the full-scale bioventing system in March 1996, as soil sampling was not included as part of the Option 1 testing activities under the extended program. However, based on soil data collected from the site in 1996, contamination levels exceeded the generic action levels for toluene, ethylbenzene, and xylenes, and exceeded the generic screening level for TPH prior to installation of the full-scale bioventing system. Table 1 provides a summary of soil analytical results obtained during March 1996 sampling, and compares these results to the TNRCC generic screening and action levels.

SOIL GAS CHEMISTRY RESULTS

Field soil gas screening and collection of soil gas samples for laboratory analysis were performed on 7 April 1997 following 28 days of system shutdown. Soil gas samples collected from all MPs and VWs were field-screened to assess concentrations of oxygen, carbon dioxide, and TVH. Results presented in Table 2 show varying oxygen levels with some increases and some decreases when compared to March 1996 values. With the exception of the three VWs and MPC-20, oxygen concentrations decreased slightly compared to the March 1996 values. The general decrease in oxygen concentrations indicates continuing aerobic biodegradation of residual fuel hydrocarbons in soils at these locations. The higher initial oxygen concentrations may be attributable to the soil gas having been diluted with oxygen-rich air introduced to the subsurface during drilling and VW/MP construction. Although oxygen concentrations indicate continuing aerobic activity, overall reductions in soil gas TVH and BTEX

concentrations indicate that the levels of hydrocarbons remaining in the soils have been greatly reduced during the 1-year period of full-scale bioventing treatment.

With the exception of the 10- and 15-foot depths at MPA, TVH field screening results from the VWs and all other MPs indicate a one- to two-order-of-magnitude reduction from initial measurements. Higher 1-year TVH concentrations measured at the 10- and 15-foot depths at MPA may be the result of vapors migrating from areas with higher soil hydrocarbon concentrations. Soil gas analytical data collected 1 year after full-scale system startup further indicate substantial overall reductions in soil hydrocarbon contamination.

Pre-startup and 1-year soil gas samples for laboratory analysis were collected at MPA-21, MPB-15, MPB-20, MPC-15, and MPC-20 (Table 2). Samples from both sampling events were sent to Air Toxics, Ltd. in Folsom, California and analyzed for TVH and BTEX using USEPA Method TO-3. BTEX concentrations in soil gas were reduced one to three orders of magnitude during the first year of system operation, and TVH concentrations were reduced one to two orders of magnitude during the same period. Field and analytical soil gas results strongly suggest significant remediation of hydrocarbon contaminants at FSA-1.

RESPIRATION TEST RESULTS

A 1-year *in situ* respiration test was performed at FSA-1 in the vicinity of the former USTs (Tanks 19 and 20) from 8 through 10 April 1997. The test was performed according to procedures outlined in the FSA-1 Remedial Action Plan (Parsons, 1996a) and followed 28 days of bioventing system shutdown. Air was injected for 22 hours into MPA-21, MPB-20, and MPC-20, using 1-cubic-foot-per-minute (cfm) pumps, to locally oxygenate site soils. Following air injection the changes in oxygen, carbon dioxide, and TVH soil gas concentrations were monitored over a 44-hour period. Observed rates of oxygen utilization were then used to estimate aerobic fuel biodegradation rates at FSA-1. Table 3 summarizes initial and 1-year respiration and fuel biodegradation rates at the site.

Observed oxygen utilization rates have decreased significantly as a result of full-scale bioventing system operation at FSA-1. Results from Table 3 show the reductions in respiration rates measured at all locations tested following the 1-year period of full-scale system operation. Estimated average fuel biodegradation rates decreased from 937 mg/kg to 210 mg/kg. Oxygen utilization and fuel biodegradation rates typically decrease with continued bioventing as the lighter, more readily biodegraded hydrocarbons are preferentially destroyed, leaving the higher-molecular-weight, more recalcitrant hydrocarbons. The BTEX compounds, as demonstrated by the soil gas results, have been almost completely biodegraded.

RECOMMENDATIONS

Based on pre-startup soil and soil gas sampling results and soil gas and respiration testing results obtained following one year of full-scale bioventing system operation, it is recommended that confirmation soil sampling (Option 2) activities be initiated for Site FSA-1. Parsons ES recommends soil sampling to document the degree of soil remediation achieved as the result of full-scale bioventing system operation at this site. Because the remediation of vadose zone soils will remove the primary source of groundwater contamination, soil sampling results may be used to better define requirements for voluntary long-term groundwater monitoring at this site. Because 1-year soil gas sampling and respiration testing results indicate that low concentrations of contaminants remain in the soils, Parsons ES recommends that the bioventing system operate for an additional 6 months to further reduce contaminant levels prior to performing confirmatory soil sampling.

If AFCEE and Wright-Patterson AFB (WPAFB) agree with performing confirmation soil sampling, a sampling and analysis plan (SAP) would be developed, soil sampling would be performed, and a soil sampling report prepared and submitted to AFCEE, WPAFB, and Lockheed-Martin (the AFP4 operator).

If you have any questions or require additional information, please contact either John Hall at (970) 244-8829 or me at (303) 831-8100.

Sincerely,

PARSONS ENGINEERING SCIENCE, INC.

JWR for JFH

John F. Hall, P.E.
Site Manager

John W. Ratz, P.E.
Project Manager

cc: Mr. John Doepker, Wright-Patterson AFB
Mr. Luke Gilpin, Lockheed-Martin
File 726876.17110 Letter Results Report

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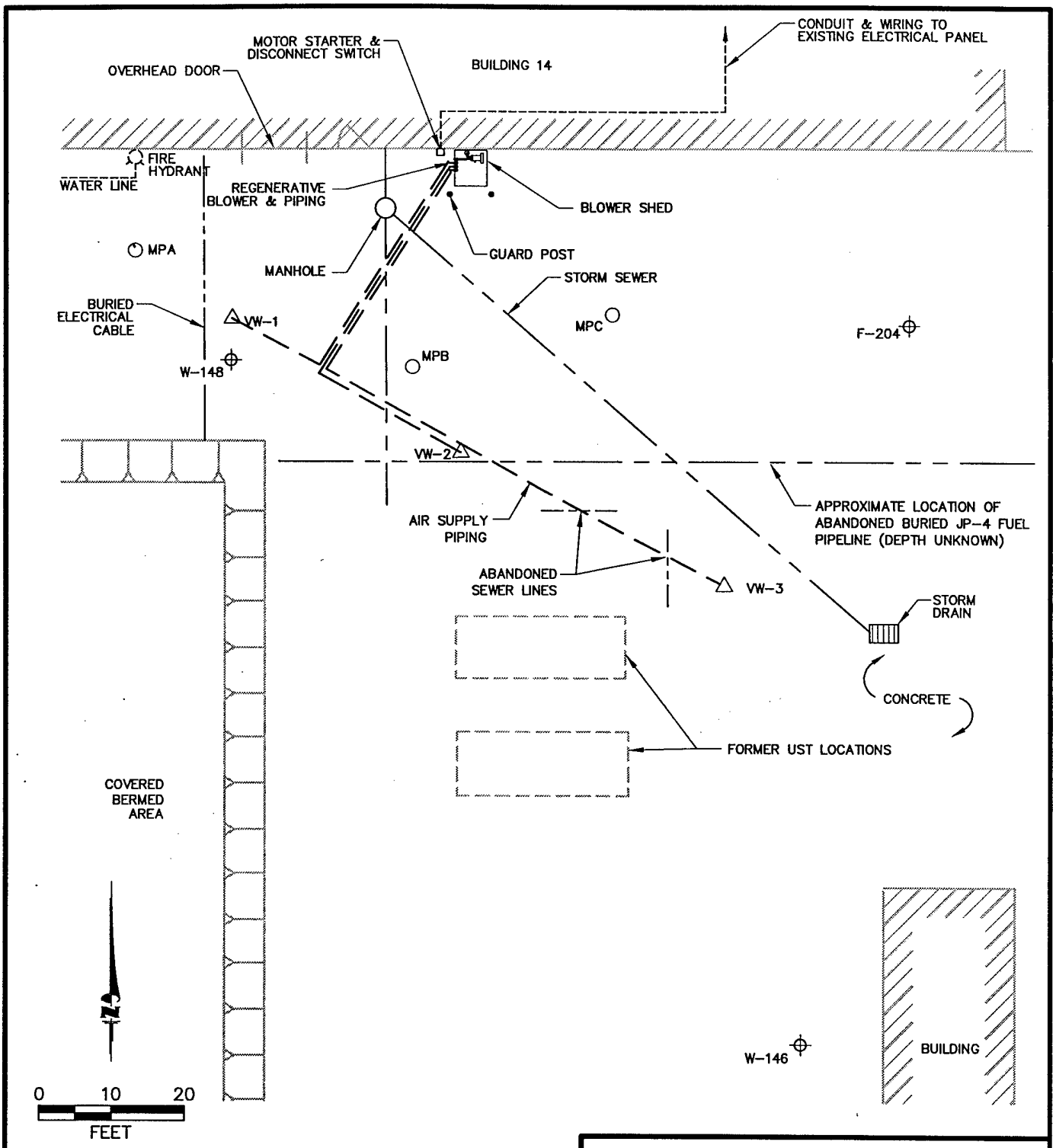

LEGEND

- F-204 ⊕ — GROUNDWATER MONITORING WELL
- MPB ○ — SOIL GAS MONITORING POINT
- VW-1 △ — VENT WELL
- — — — HEADER PIPE TO VENT WELL

FIGURE 1

SITE LAYOUT

FSA-1
Air Force Plant No. 4, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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TABLE 1
INITIAL SOIL ANALYTICAL RESULTS COMPARED TO TNRCC CRITERIA
SITE FSA-1
AIR FORCE PLANT 4, TEXAS

	Analyte[a/]				
	TPH (mg/kg)[b/]	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)
Action Level[c/]	----[d/]	0.5	100	70	560
Screening Level[e/]	100	----	----	----	----
Sampling Location[f/]					
VW2-20	16.9 U[g/]	ND	0.002	ND	ND
VW3-20	**980**[h/]	100 U	**540**	**170**	**1,100**
MPA-21	46	0.02 U	0.034	0.006	0.025
MPB-20	**7,300**	0.4 J[i/]	**1,500**	5	51J
MPC-20	23	0.02 U	0.014 J	0.011 J	0.160

[a/] TPH = total petroleum hydrocarbons analyzed by USEPA Method SW8015 (modified); BTEX analyzed by USEPA Method SW8020; soil sampling performed in March 1996.

[b/] mg/kg = milligrams per kilogram.

[c/] Texas Natural Resource Conservation Commission (TNRCC) generic soil action level.

[d/] ---- = Not applicable. Level has not been established for this analyte.

[e/] TNRCC generic soil screening level.

[f/] Sample location gives location of boring and sample depth in feet below ground surface.

[g/] U - compound analyzed for, but not detected. Number shown represents the method detection limit.

[h/] Box - Concentration exceeds the TNRCC action or screening level.

[i/] J - Indicates an estimated value. The compound was detected but was below the reporting limit.

TABLE 2

INITIAL AND 1-YEAR FIELD AND LABORATORY SOIL GAS ANALYTICAL RESULTS

SITE FSA-1

AIR FORCE PLANT 4, TEXAS

			Field Screening Data			Analytical Data[a/]				
Sampling Location	Screen Depth (feet bgs)	Sampling Event[b/]	Oxygen (%)	Carbon Dioxide (%)	Field TVH[c/] (ppmv)[d/]	Laboratory TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzen (ppmv)	Xylenes (ppmv)
VW1	12-27	Initial	0.5	14.8	> 20,000[e/]	---[f/]	---	---	---	---
		1-Year	4.0	2.5	3,200	---	---	---	---	---
VW2	10-25	Initial	12.0	6.5	1,240	---	---	---	---	---
		1-Year	16.5	0.9	360	---	---	---	---	---
VW3	10-25	Initial	14.0	5.0	18,000	---	---	---	---	---
		1-Year	16.4	0.5	168	---	---	---	---	---
MPA	10	Initial	20.5	0.5	180	---	---	---	---	---
		1-Year	19.5	1.0	360	---	---	---	---	---
MPA	15	Initial	20.8	0.4	58	---	---	---	---	---
		1-Year	14.7	1.4	386	---	---	---	---	---
MPA	21	Initial	0.8	11.5	> 20,000	2,500	6.7	7.2	84	130
		1-Year	0.2	3.2	2,800	110	0.05	0.006U[g/]	0.14	0.26
MPB	10	Initial	20.4	0.6	1,100	---	---	---	---	---
		1-Year	10.0	1.3	680	---	---	---	---	---
MPB	15	Initial	3.5	12.0	> 20,000	1,600	2.4	850	2.1U	5.8
		1-Year	0.0	3.9	1,400	95	0.022U	4.2	0.067	0.42
MPB	20	Initial	1.5	15.8	> 20,000	46,000	51U	28,000	51U	51U
		1-Year	0.0	2.0	12,200	1,700	0.48U	93	0.72	24
MPC	10	Initial	20.0	0.7	1,000	---	---	---	---	---
		1-Year	18.3	0.1	280	---	---	---	---	---
MPC	15	Initial	19.5	0.7	1,560	370	0.034U	4.3	0.18	4.8
		1-Year	14.1	0.1	240	54	0.002U	0.11	0.03	0.29
MPC	20	Initial	2.3	12.5	> 20,000	2,500	0.51U	10	26	480
		1-Year	8.1	0.7	520	61	0.002U	0.006	0.075	0.58

[a/] Laboratory analysis of soil gas performed using USEPA Method TO-3. Laboratory TVH referenced to jet fuel (MW=156).

[b/] Soil gas sampling performed in March 1996 (initial event) and April 1997 (1-year event).

[c/] TVH = total volatile hydrocarbons.

[d/] ppmv = parts per million, volume per volume.

[e/] > indicates that concentration exceeded the instrument range. Number shown represents the instrument's maximum detection limit.

[f/] --- = not analyzed.

[g/] U = compound analyzed for but not detected. Number shown represents the method detection limit.

TABLE 3
INITIAL AND 1-YEAR RESPIRATION AND FUEL BIODEGRADATION RATES
SITE FSA-1
AIR FORCE PLANT 4, TEXAS

	Initial (March 1996)		1-Year (April 1997)	
Location-Depth[a/]	Respiration Rate (% oxygen/hour)	Biodegradation Rate[b/] (mg/kg/year)[c/]	Respiration Rate (% oxygen/hour)	Biodegradation Rate (mg/kg/year)[c/]
MPA-21	0.75	1940	0.024	60
MPB-20	0.21	490	0.198	450
MPC-20	0.15	380	0.044	120
Average Rates	0.37	937	0.089	210

[a/] Location-Depth gives screened interval location and depth below ground surface.
[b/] Initial and 1-year degradation rates based on moisture content of the soil during initial sampling; 1-year soil sampling was not performed.
[c/] Milligrams of hydrocarbons per kilogram of soil per year.